OBSERVATIONS ON A GALL APHID (APHIS ATRIPLICIS L.).*

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The subject of this article is the common greenish insect of the genus *Aphis* which colonizes the dorsal surface of the leaves of the white goosefoot or lamb's quarters, *Chenopodium album*, and the nearly allied orache, *Atriplex patula*, in summer. The margins of the infested portion of the leaf always curl up longitudinally and meet above the midrib, forming an imperfectly closed tube.

According to the determinations of Mr. T. A. Williams and of Doctor Forbes, *Aphis atriplicis* also attacks the leaves of cultivated beets in Nebraska and Illinois. This would not be at all surprising, since the genus *Beta* is closely related to *Chenopodium* and *Atriplex*. Doctor Bruner wrote me that Mr. Williams was well acquainted with the insect and knew its characteristic habits on goosefoot. This aphid is very abundant on the common goosefoot and orache, from which it might easily become troublesome on beets.

At Fredonia, N. Y., it was everywhere abundant on the white goosefoot during August, 1908, when I first became familiar with its habits, although I did not determine it specifically until the following January. Most plants of this host were badly infested both in the vicinity of Fredonia and also at Lily Dale, Jamestown, and Chautauqua, N. Y. It has been reported as infesting this plant from Missouri, Kansas, Minnesota, Colorado, Illinois and Nebraska. Professor G. Del Guercio, Florence, Italy, writes me that this species is everywhere common in Europe on plants of the goosefoot family. I find in the literature that it has been reported from the following countries: Sweden, Germany, Italy, England and Belgium.

In habits this species is unique. The insects were infesting only the dorsal surface of the leaves and no other part of the plant when I was studying them last August. They were clustered chiefly along the midribs and main veins. The elongated galls (Fig. 1), which were formed by the sucking on the upper surface, partially protected the occupants from rain and sun. The margins of the leaves were never rolled in or convoluted more than I have shown in Fig. 1, a–b, which are cross sections of represen-

*Contributions from the Entomological Department of Bussey Institution, Harvard University, No. 5.

tative galls. Thus whenever the galls retained the normal position of the leaves with the dorsal surface upwards, they were easily filled with rain-water; in most cases, however, they were partly or entirely reversed bringing the ventral surface upwards and directing the long aperture of the gall downwards. Such galls were effectual water-sheds and the inhabitants were always dry, while those that were not reversed carried more or less water mixed with the excretions and exuvia of the plant lice. This liquid was evidently detrimental to the insects, many of which were killed by a parasitic fungus. An ample supply of these brownish dead aphids was sent to Professor Roland Thaxter of Harvard University, who replied as follows: "* * * * the fungus which has attacked them is *Entomophthora aphidis*, a universally distributed form with which two others are often associated. In your material, however, I see but the single species mentioned." It is clear, then, that the reversal of the gall is a decided advantage to the species. I was not able to determine how this reversal was brought about. It was evidently one of the curious effects on the leaf caused by the sucking of the insects, and may have been developed by natural selection for their protection from dampness and disease. The upturned whitish under surface of the leaf-galls rendered the infested plants very conspicuous, and gave them the deceptive appearance of being attacked by a downy mildew. I have, in fact, noticed this phenomenon in the *Chenopodiums* in Chautauqua County, N. Y., for several years and had always supposed it to be the work of a fungus until I examined them critically last summer.

A black aphid, the *Aphis rumicis* L. of authors, commonly infests the lower surface of the leaves and the inflorescence of these plants. It also sometimes occurs mixed in the colonies of the green aphids under discussion. This habit undoubtedly accounts for Buckton's mixed descriptions. The green and the black forms are entirely distinct species easily separable by pronounced structural differences, as pointed out in the descriptions farther on.

During the first week in August, 1908, the winged viviparæ (viviparous females) of *Aphis atriplicis* were leaving the galls in great numbers, a general migration being apparently at its height. After the middle of August pupæ were not common in the galls, which were almost deserted, except for a few wingless viviparæ and larvæ. Connold, 1902, observed a similar migration in August in England. I failed to find what became of the winged

females. Many individuals were found isolated on bean leaves, but none of these succeeded in establishing colonies. The migrants were certainly not depositing larvæ on the normal leaves of the *Chenopodiums*. About the middle of October, 1908, at Forest Hills, Mass. I found many small plants of this genus growing in soil that had been cultivated or newly made after July. These plants must have come up late in summer. They were covered with the galls of this species. It is evident, then, that they were colonized in August. Undoubtedly the winged females observed migrating at Fredonia in the same latitude were merely colonizers on tender young *Chenopodiums* starting up in damp situations. It is highly improbable that these were true migrants going to some distinct host. As a rule the sexes of truly migrating plant lice develop on some woody plant called the primary host, while the summer forms of the species live on a succulent herb, the secondary host. Since the sexes of *Aphis atriplicis* developed in great numbers on the *Chenopodiums* last fall, they are undoubtedly confined in their life-cycle to these plants and their allies.

On September 21st the perfect sexes were first noticed on the white goosefoot at Forest Hills. Small, lank, wingless males of a yellowish color, with blackish appendages, were actively climbing about over the large clusters of plump oviparous females, and copulation was observed as late as the 30th of October. Large numbers of these females were found abundantly on the goosefoot plants in this neighborhood. The males were few in number, between 5 and 10 per cent. of the total number of individuals (by guess). But they were making up for their fewness by great activity, and copulation was often seen. Most of the females had left the summer galls and were on the seed-heads, where they were frequently mixed with black aphids, the so-called *Aphis rumicis*. Only a small proportion of the individuals were found in the galls during the periods of oviposition. No viviparæ were seen at Forest Hills, and of many specimens taken throughout the fall, none proved to be viviparous on examination in the laboratory. Viviparity doubtless ceases or becomes exceptional in this species with the development of the perfect sexes. There is evidently a general migration of these sexes or of the sexuparæ producing them from the galls to the seed-heads in the fall, where the eggs are usually laid. Oviposition was observed during the entire month of October. The eggs were at first light yellow in color, then deep green, finally becoming shin-

ing black a few days after they were laid. They were generally placed irregularly on the calyces and seed capsules and on the small leaves of the upper branches. I examined many of the large galls finding some eggs in them, but not nearly so many as on the seed-heads. On October 21st I did find many eggs in some frosted wilted leaves. The general instinct of the females was plainly to carry the egg-laying as far up towards the seed-bearing portion as possible. On Nov. 11th no more living aphids of this species were found, for a freeze had killed all the *Chenopodiums*.

This habit of ovipositing on or close to the seeds is an instructive adaptation to the nature of the host. The winds and storms of the winter of 1909 have broken off all the seed-heads and leaves of the *Chenopodiums*, and at the time of writing (April) even the bare stalks of the plants rarely remain standing. The seeds have been distributed far and wide and many of the eggs of the aphids must have been carried with them. The young stem-mothers on hatching will be able to find their natural food easily available. Were most of the eggs laid on the leaves, they would be so scattered by the winds that very few of the larvæ could find suitable food in the spring. Since most species of *Chenopodium* and *Atriplex* are annual, the stem-mothers would suffer the same mishap if the eggs from which they hatched had been laid on the ground beneath the host. In October and November, 1905, at Columbia, Missouri I observed the large red *Macrosiphum rudbeckiæ* Fitch ovipositing in great numbers on the debris under one of its hosts, a perennial goldenrod. In this case new shoots would have come up in the spring around the old plants, and the larvæ on hatching would have found ready food. Here then, there was no necessity of the mothers entrusting their progeny to the capriciousness of the windy winter elements.

The oviposition of our goosefoot aphid in the seed-heads explains its world-wide distribution. Professor M. L. Fernald, Harvard University, has written to me that *Chenopodium album* is known to be an introduced plant from Europe, whence it has followed the trail of the early American settlers. In Professor Fernald's own explorations in the forests of Maine, New Brunswick and Quebec this plant was never found except about settlements. *Atriplex patula* is likewise recognized as an introduced species. These plants are both common European garden weeds whose seeds, with the eggs of their insect foes, could easily be introduced with any rubbish into a new country.

The wingless males are interesting types of degeneration (Fig. 3). They have not only lost their wings, but the thoracic lobes are also disappearing. In most specimens of about a score examined these structures are distinctly traceable, although reduced, and compare well with those of any winged form of the genus *Aphis;* but in some individuals they are degraded to mere vestiges in the shape of irregular dusky marks. In these more degenerate specimens only the ocelli, present in all winged aphids, prove that they were, until comparatively recently, winged insects. In this species we may hope to find occasional males still retaining their wings. Weed has shown that both winged and wingless males occur in *Cladobius salicis* L., and Gillette has found both forms in *Aphis torticauda* Gillette. No winged males of *Aphis atriplicis* were found this fall, although I kept this possibility constantly in view. On October 15th I did find three winged males in copulation with females of this species, but the males could not possibly be the same species, for they were generically distinct. This observation suggests the possibility of hybridization in the plant lice. Weed in 1891 observed the copulation of a male of *Cladobius salicti* Harris with a female of *Lachnus platanicola* Riley. These records also teach us that the mere pairing of two plant lice does not prove their specific or generic identity. The former can, however, be safely inferred when many males are found pairing with a large number of females possessing similar structural characters.

The wingless males of a red *Myzus* (?) on cherry (not *Myzus cerasi* Fab.) collected at Forest Hills last fall, have degenerated much farther than those of our *Chenopodium* aphid. Here all traces of thoracic lobes have disappeared, and the ocelli are scarcely discernible. A still farther step in degeneration has apparently taken place in the wingless male of the corn-root aphis (*Aphis maidi-radicis* Forbes), if we may judge from Forbes' figure and the descriptions by the same writer, Weed, and Davis, in which no mention is made of the ocelli. There would be no way of recognizing this male as a descendant of a winged male ancestor were it not for these intermediate forms, which I have discovered. This process of reduction of structures correlated with the organs of flight is an instructive illustration of what must have occurred long before in the evolution of the wingless vivipara, which has even lost all traces of ocelli. These facts also suggest the probability that this female in the *Aphididæ* is not a case of pædogenesis as

usually supposed, but is morphologically equivalent to a winged vivipara which has lost her organs of flight and all correlated structures through disuse. Living as parasitic insects in the midst of a luxuriant supply of food all superfluous structures have been dispensed with according to the well known laws of parasitism. When the males of a species are wingless, they must pair with females which have developed on the same plant and which may be of the same descent. The general migration of *Aphis atriplicis* in August observed by Connold and myself undoubtedly tends to counteract cross fertilization, since the bisexual colonies on any plant in the fall would be of mixed descent. According to the literature which I have seen, wingless males are known in the following species: *Pemphigus attenuatus* Osborn, *Schizoneura corni* Fab., *S. americana* Riley, *S. lanigera* Hausm., *Hamamelistes spinosus* Shim., *Hormaphis hamamelidis* Osten Sacken, *Chermes* and *Phylloxera*, all species as far as known, *Melanoxanthus salicis* L., *Lachnus nudus* De G., *L. piceicola* Cholodk., *Aphis maidiradicis* Forbes, *A. atriplicis* L., *A. mali* Fab., *A. carbocolor* Gillette, *A. torticauda* Gillette. Buckton reports wingless males in ten other species, but since I know the winged males in four of these and since his work seems so generally superficial, I do not give his list.

Aphis atriplicis was greatly parasitized both at Fredonia and at Forest Hills. On some plants nearly all the aphids were killed. I am indebted to Mr. C. T. Brues, Curator, Public Museum of the City of Milwaukee, Milwaukee, Wis., for the determination of the following parasites which I reared from this species: *Lysiphlebus cragrostaphidis* Ashm., Fredonia, N. Y., Aug. 3, 1908. Several specimens. From viviparous aphids. The other parasites were all reared from Forest Hills material and must have developed very largely in the oviparous insects. *Lysiphlebus cragrostaphidis* Ashm., Oct., 10, 23 and 30; many specimens. *Pachyneuron micans* Howard. Oct. 30, one specimen. *Asaphes rufipes* Brues, n. sp. Oct. 30, four specimens. *Aphycus* ? sp. an *Encyrtid*. Oct. 30, one specimen. *Figites*, sens. lat., aberrant *Cynipidæ*. Mr. William Beutenmuller suggests that these may belong to the genus, *Allobia*, known to be parasitic in plant lice, but no one in this country has time to study them for me. Oct. 30, nine specimens.

Several lady beetles were collected from galls of this aphid at Fredonia. Adult examples of these were kindly determined for

me by Mr. E. A. Schwarz through the courtesy of Doctor Howard as *Scymnus americanus* Muls. and *Hippodamia* 13-*punctata* L.

The aphids were not attended by ants. This may have been due to the dry time of the year, when, as Professor Wheeler tells me, these insects are not generally so active outside of their galleries. It is possible, however, that *Aphis atriplicis* does not attract ants at any time of the year. Mr. J. J. Davis has found that *Sipha flava* Forbes is never attended by ants in Illinois and I have noticed the same fact relating to this species in the early summer in Virginia and New York when ants were plentiful in the colonies of other aphids. It is also a matter of common observation that woolly aphids are rarely or never cared for by ants.

The identification of this species was not difficult on account of its peculiar habits. The original description by Linnæus is as follows: "Habitat in Atriplicis littoralis foliis, quae inde revoluntur longitudinaliter in cylindrum, intra quem vagantur obtectæ. Descr. Corpus viride: corniculis minutis. Oculi nigri." It will be seen that this description is less ambiguous than those of many species unhesitatingly referred to Linnæus, and I prefer to use it to avoid multiplying names. Specimens of the winged and wingless viviparæ were sent to Professor Del Guercio who is familiar with the species in Europe, and he found them to be identical. He placed this species in his genus *Uraphis* which is distinguished from other subdivisions of *Aphis* by the cornicles being shorter than the cauda. Since the cornicles are distinctly incrassate, he proposed a new subgenus of *Uraphis*, to be called *Hayhurstia* Del G. This subgenus would then include all species of *Aphis* with incrassate cornicles which are shorter than the cauda. Del Guercio separates *Siphocoryne* Pass. from *Aphis* by the cornicles which are "more or less long, clavate." (Nuov. Relazioni R. Stazione di Ent. Agrar. Firenze (1) No. 2, 1900, p. 142). By general consent those species of Aphis with more or less clavate cornicles which are longer than the cauda have been put in the poorly defined genus, *Siphocoryne*. In other words, *Hayhurstia* Del G. is separated from *Siphocoryne* Pass. merely by the length of the cornicles and a supposed difference between *clavate* and *incrassate*. These I consider too indefinite to be reliable generic characters. When forms are found with the cornicles *about* the length of the cauda, very careful measurements must be taken to determine the genus, and ocular micrometers are not always at

hand. Since every gradation exists in the degree of the bulge in the cornicles of the genus *Siphocoryne* from forms like *S. salicis* Monell down to *S. avenae* Fab. which is scarcely incrassate at all and that on the inner side, I cannot recognize either *Siphocoryne* or *Hayhurstia* as valid genera, but would rank them both as subgenera of the genus *Aphis*. I therefore consider the following grouping of those species of *Aphis* and *Siphocoryne* with a distinct cauda worth testing. This is modified from Del Guercio's revision of *Aphis* (Redia, Firenze Vol. 4, Fasc. 1, 1906, pp. 191–2.)

1. Cornicles longer than cauda.
   a. Cornicles cylindrical or gradually attenuated from base.
      Subgenus **Aphis** L. (Fig. 13.)
         Aphis sambuci L.
   b. Cornicles clavate or incrassate at or beyond base.
      Subgenus **Siphocoryne** Pass. (Fig. 11.)
         Aphis nymphææ L.
2. Cornicles equal to cauda or shorter.
   a. Cornicles cylindrical or gradually attenuated from base.
      1. Cornicles shorter than style.
         Subgenus **Uraphis** Del G.
            Aphis genistæ Koch.
      2. Cornicles equal to style.
         Subgenus **Microsiphon** Del G.
            Aphis tarmentillæ Pass.
   b. Cornicles incrassate.
      N. Subgenus **Hayhurstia** Del G. (Fig. 12.)
         Aphis atriplicis L.

Aphis atriplicis L. seems never to have been carefully described. In the following descriptions all colors were taken from the living insects with a high power hand lens, daylight, and many individuals were compared. All measurements of the bodies are from formalin material and are therefore reliable, while those of the appendages are from balsam mounts; the lengths given are averages of six or more representative specimens. Figures in parentheses are extremes. Del Guercio states that the colors especially of the wingless viviparæ in Italy vary greatly according to the host and other conditions so that "now greenish-yellow forms preponderate, and now those of a yellowish-green, green, olive green and olive color, sometimes, indeed, so deep in tint as to seem brownish with greenish reflections."

The lobes of the mesothorax are figured for clearness, because they are not generally mentioned individually by authors (Fig. 2). Their color is here treated as of specific value, but their form is not described for this purpose. Their structural details present marked constant differences, which have apparently never been carefully studied. They are already called the prescutum, scu-

tum, (scutal lobes), scutellum and postscutellum by some aphidologists, and I accordingly use the same terms, although I do not know their homologies. I avoid the long term *viviparous female* giving preference to its simple equivalent, *vivipara* (pl.–æ), which, being a classical word of the feminine gender, means literally *the viviparous female*. Since all viviparous plant lice are necessarily females, I can see no ambiguity in the use of this word.

Winged vivipara. Head dusky green; antennæ dusky with pale articulations, sparsely hairy, joint III, usual number of sensoria 9 or 10, sometimes 11–13 (Figs. 10, 15, 18); eyes dark red; beak extending beyond transverse sternal suture, but not reaching middle coxæ. *Pronotum* dusky green; lateral tubercles present, not prominent, longer than broad. Mesothorax greenish yellow; prescutum, scutal lobes and postscutellum blackish, scutellum (in formalin) brownish with black anterior and posterior margins; mesosternal plates brown, metasternal region dusky; 1st and 2nd discoidal veins of the forewing more or less distinctly joined to radius, never completely atrophied at base (Fig. 6). Base of femora brownish yellow, elsewhere dusky; tibiæ brownish yellow with dusky apex, tarsi dusky to black. *Abdomen* green, varying to yellowish green. Dorsum with irregular, variable, dusky maculations, most commonly resembling Fig. 5. The four large lateral spots in front of the cornicles distinct, dusky to blackish. The seven small, lateral, obtuse tubercles distinct but not conspicuous, mostly broader than long (Fig. 5). Cornicles dusky, swollen at and beyond the middle, a little shorter than hind tarsus, surface smooth, never imbricated (Figs. 8, 12); cauda uniformly pale yellowish from base to apex, the margins black anterior to the distinct median constriction, posterior to which are 3 pairs of long curved setæ; anal plate beset with several similar setæ, 6–8 along posterior margin.

Measurements. (Antennæ measured from base of III to apex of filament). Length of body, head to base of tail, 1.49 mm. (1.39–1.70); greatest width of abdomen, .662 (.61–.696). Antennæ, .97–1.00; III, .335; IV, .155; V, 155; VI (scape) .107, filament, .25. Forewing, 2.0–2.26. Cornicles, 0.12; cauda, 0.155.

Pupa. Color similar to the winged vivipara, with indistinct or no maculations except irregular deeper green marks on mesothorax; wing-pads dusky.

Wingless vivipara. Head dusky yellow with two median dusky spots close together. Antennæ I–II concolorous, elsewhere light brownish, the distal joints becoming dusky; without sensoria except the usual one at apex of V and the group at the apex of the scape of VI. Eyes reddish black or black. Beak extending to or a little beyond mesocoxæ. *Thorax* yellowish green varying to green; a dusky dorsolateral impressed spot on each segment, the one on the mesothorax longitudinal linear, often broken into a row of small spots; thorax otherwise without maculations. Distinct prothoracic lateral tubercle, longer than broad. Legs yellowish-brown except the dusky apex of tibiæ and the tarsi. *Abdomen* concolorous with thorax, without macu-

lations except 4 or 5 small dusky spots forming a dorso-lateral longitudinal row continuous with the thoracic spots, the last distinct spot on about the 5th segment; one indistinct spot just mesal to the cornicle, often absent. Cornicles yellowish with apex dusky, the entire appendage usually not dusky. Whole body lightly pulverulent. Otherwise as in winged vivipara.

Measurements—Length of body, 1.54 mm. (1.35–1.70), width, .609 (.522–.696). Antennæ .584 (.516–.705); III .20, IV, .077, V .09, VI (scape) .077, filament .142. Cornicles, .111, cauda, .172.

Oviparа. This form can be easily told with a hand-lens from the wingless vivipara by the dusky incrassate hind tibiæ with many sensoria and the blackish vaginal plate. Detailed description as follows: Eyes black, rarely reddish black. Legs dusky except the yellowish-brown base of femora and greater proximal portion of fore and middle tibiæ, hind tibiæ dusky, proximal half swollen, 30–40 nearly circular sensoria on both anterior and posterior aspects (Fig. 4). Cornicles dusky: Cauda pale yellowish distally, or entirely dusky; often not constricted. Otherwise similar to the wingless vivipara.

Measurements. Length of body, 1.45 mm. (1.24–1.70), width .565 (.478–.652). Antennæ .553 (.516–.671); III .129, IV .06, V .0774, VI (scape) .077, filament, .122. Cornicles, .112, cauda, .146.

Wingless male. Head and antennæ dusky to blackish. Antennæ (Fig. 17) with average number of sensoria as follows (extremes in parentheses): joint III, 14–15 (11–24); IV, 9–10 (7–14); V, 10–11 (10–14); VI, usual group at apex of scape, often with a single sensorium near its middle. Eyes blackish red; ocelli conspicuous. Beak extending just beyond mesocoxæ. *Pronotum* dusky, lateral tubercle distinct, mesothoracic lobes brownish to dusky, traceable as in Fig. 3; in several specimens they are reduced to irregular dusky marks. Legs dusky to blackish. *Abdomen* dusky yellow, very variable in the tint of yellow, dorsum with irregular, variable dusky marks, usually resembling Fig. 3. Lateral tubercles relatively more pronounced than in the females. Cornicles dusky. Cauda dusky, not constricted (Fig. 19). Otherwise as in winged vivipara.

Measurements. Length of body, 1 mm. (.957–1.04), width, .481 (.430–.550). Antennæ .89 (.72–1.02); III, .258; IV, .142; V, .142, VI (scape) .094, filament, .215. Cornicles, .066; cauda, .113.

Eggs, oval, shining black, .60 x .327 mm. Dissection of many oviparæ collected Oct. 9th, showed that each individual contained from one to eight eggs. The number evidently depended on the size as well as the age, since some large specimens were opened that contained no eggs. The usual number was two to six.

The common black aphid infesting the *Chenopodiums*, as stated above, is entirely distinct from *Aphis atriplicis* L. For the sake of comparison I have drawn the principal systematic differences which may be summarized as follows:

Winged vivipara—Antennæ with many (fully 15–16) sensoria on joint III; 4–5 on IV (Fig. 16). Basal half of costal vein of fore-wing strongly bent anteriorly, bases of 1st and 2nd discoidals always com-

pletely atrophied. Cornicles (Figs. 9, 13), never swollen, but broad at base tapering gradually to apex, distinctly imbricated, black, about 1.5 times length of hind tarsus. Cauda (Fig. 14), stouter, apex more rounded, beset with many stout curved setæ, bicolored, the basal half between the black margins being pale yellowish, while the distal half is dusky to blackish. The prothoracic and 2nd and last abdominal tubercles very pronounced, longer than broad.

Measurements. Length of body, 2 mm. width .98; antennæ 1.25; wing 2.75; cornicles, .20; cauda, 1.5 (averages from several specimens.)

The life history of this black aphid is different from the green species. It never forms galls, usually infests the under side of the leaves or the inflorescence in summer as well as fall, attacks *Rumex* and other weeds besides the *Chenopodiaceæ;* and migrates in the fall from these plants to the wahoo (*Euonymus atropurpurea.*) I observed this migration to the wahoo last fall at Forest Hills where the so-called sexuparæ were depositing oviparous larvæ on the under side of the leaves. These true migrants were precisely identical in structure with the winged viviparæ on *Chenopodium.*

Osborn established the migration of this wahoo aphid (*Aphis rumicis* ? L. = A. euonymi Fab.) in Iowa in 1894. Either this species or a closely similar one migrates between the same hosts in Europe.

It is my privilege to acknowledge Professor Wheeler's kind criticisms in the preparation of this article.

LITERATURE

Aphis atriplicis Fab., Fabricius, Syst. Ent., 1775, p. 737, No. 21, is a distinct species belonging to the Aphis rumicis group.

Aphis atriplicis L., Linnæus, Fauna Svecica (ed. altera), 1761, p. 262, No. 1000. Original description. Sweden. Atriplex littoralis.

= chenopodii Schr., Schrank, Fauna Boica, Vol. 2, Pt. 1, 1801, p. 109, No. 1196. Bavaria, Atriplex patula; descriptions of winged and wingless viviparæ.

Kaltenbach, J. H., Monogr. d. Pflanzenl., 1843, pp. 107–108. Germany. Chenopodium album, Atriplex patula. Descriptions of winged and wingless viviparæ.

Passerini, G., Gli Afidi, 1860, p. 31. Italy.

Ib. Flora degli Afidi Ital., in Bull. Ent. Soc. Ital. 3, 1871, pp. 151, 155. On Atriplex patula and Chenopodium album.

Kaltenbach, J. H., Pflanzenfeinde, 1874, pp. 505, 508. In Germany. Same hosts and habits. Sometimes affects all the leaves of the plants making the leaves appear yellowed and sickly.

Buckton, G. B., British Aphides, Vol. 2, 1879, pp. 87–90, col. pl. 65, figs. 4–7. All descriptions and figures apply to an insect of the Aphis rumicis type except possibly the wingless male and the ovipara which apparently belong to Aphis atriplis L. Notes on the galls and oviposition in the galls. Atriplex sp. England.

Monell, J., Bull. U. S. Geol. & Geogr. Surv. Terr. Vol. 5, No. 1, 1879, p. 25. Common on Chenopodiums at St. Louis, Mo., and at Carbondale, Ill. (Thomas, C. 8th report Ins. Ill., 1879, p. 193.)

Lichtenstein, J., Les Pucerons, 1884, Chap. 4 (La Flore des Aphidiens) pp. 80, 85. Atriplex and Chenopodium.

Oestlund, O. W., Ann. Rept. Geol. & Nat. Hist. Surv. Minn., 14, 1886, p. 47. Minnesota, Chenopodium album. (Ib., Bull. 4, Geol. & Nat. Hist. Surv. Minn., 1887, p. 69.)

Bruner, L., U. S. Dept. Agric. Bur. Ent. Bull. 23 (o. s.) 1891, p. 17. On the beet at Ashland, Nebr. (T. A. Williams.)

Williams, T. A., Univ. Nebr., Dept. Ent., Special Bull. 1., 1891, pp. 6, 10, 12, 20. Nebr. On cultivated beet, Rumex altissimus, Chenopodium album and hydridum.

chenopodii Cowen., Cowen, J. H., Colo. A. E. S. Bull. 31 (Tech. Ser. No. 1), 1895, p. 119. Descriptions of winged and wingless viviparæ and galls. Colo., Chenopodium album; galls collected in July.

Del Guercio, G., Nuov. Relazioni R. Staz. Ent. Agrar. Firenze (1) No. 2, 1900, pp. 124, 132. Italy. Differential characters in table of species of Aphis. Chenopodium album and Atriplex patula.

Forbes, S. A., Bull. 60, Ill., A. E. S. 1900, p. 430. Illinois. Eggs in dried rolled leaves of Atriplex. Suggests that this species may be identical with Aphis gossypii Glover. (I do not think this possible. The two species have totally different cornicles, those of Aphis gossypii are much longer than the 4th tarsus, incrassate at the base, elsewhere cylindrical, imbricated, black.)

Hunter, W. D., Bull. 60, Iowa A. E. S., 1901, p. 93. Partial bibliography. Hosts, distribution.

Connold, E. T., British Vegetable Galls, 1902, pp. 233–4, pl. 101. England. Atriplex augustifolia and patula. Abundant along the coast and inland. Winged viviparæ emerge in August. All stages including sexes and ova in galls during the fall. (Notes on the insects show that he evidently had colonies mixed with Aphis rumicis (?). Photograph of infested plants showing galls.

Bignell, G. C., Ann. Rept., 72 Roy. Cornwall Polytech. Soc. 1904, p. 24 (Separate) England. Atriplex latifolia.

Luff, W. A., Guernsey Soc. Nat. Sci., Rept. and Trans. for 1905, p. 88. Mention.

Schouteden, H., Cat. d. Aphides de Belgique. in Mem. Soc. Ent. Belg. 12, p. 216. Belgium; Atriplex, Chenopodium album.

Sanborn, C. E., Kansas Univ., Sci. Bull. Vol. 3, No. 8, 1906, pp. 232, 235, 248, 254, 255. Compiled list of hosts.

PLATE XV.

FIG. 1. Leaf-gall; *a*, *b*, cross-sections.
FIG. 2. Winged vivipara. *pt.*, pronotum; *lt.*, lateral tubercle; *p.*, prescutum; *s.*, scutal lobes; *sl.*, scutellum; *ps.*, post-scutellum; *mt.*, metatergite.
FIG. 3. Wingless male.
FIG. 4. Ovipara, hind tibia.
FIG. 5. Winged vivipara.
FIG. 6. Forewing of same.
FIG. 7. Forewing of *Aphis rumicis* (?).
FIG. 8. Cornicle of *Aphis atriplicis*, distal end.
FIG. 9. Cornicle of *Aphis rumicis* (?), distal end.
FIG. 10. Third antennal joints of *Aphis atriplicis*, winged vivipara, from same individual.
FIG. 11. Cornicles, two variations in the bulge in subgenus *Siphocoryne*.
FIG. 12. Cornicle of *Aphis atriplicis*.
FIG. 13. Cornicle of *Aphis rumicis* (?).
FIG. 14. Cauda of *Aphis rumicis* (?).
FIG. 15. Third antennal joints of *Aphis atriplicis*, from four individuals.
FIG. 16. Antenna of *Aphis rumicis* (?), winged vivipara.
FIG. 17. Antenna of wingless male of *Aphis atriplicis*. (Thickness somewhat exaggerated.)
FIG. 18. Antenna of winged vivipara of *Aphis atriplicis*.
FIG. 19. Cauda of wingless male of *Aphis atriplicis*.

All figures except 1 and 2 made with camera lucida.